Effect of Processing On Selected Nutrients of Beans (*Phaseolus vulgaris*)[1]

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ABSTRACT

Twenty-two selections of dry beans (*Phaseolus vulgaris*) were commercially canned and analyzed for Ca, Mg, Fe, Mn, P, Na, Cl, K, protein (N × 6.25), and fat content before and after processing. The retention percent for Mg, Fe, Mn, P, and K were 89, 95, 89.8, 67.4, and 55.4, respectively. The Ca, Na, and Cl contents increased with processing. The increase in Ca content can be attributed to the hardness of processing water. Na and Cl were added as table salt. When all selections are taken into account, no significant differences were observed between raw dry and processed beans with respect to Fe, Mn, protein, and fat content, but there were significant differences with respect to Ca, Mg, P, Na, Cl, and K.

INTRODUCTION

Food legumes, especially beans, are an important source of protein, calories, and minerals in the diet of many countries. A substantial amount of the legumes consumed in Puerto Rico are beans canned in brine.

Food preservation plays an important role in providing a year round supply of foods. However, processing methods such as blanching and commercial sterilization influence the nutrient content of foods (8). The genetic makeup or variety as well as the growing conditions, also influence the nutrient content of foods (7). Thus, through selective breeding Hein and Hutchings (9) raised the vitamin A content of squash ten-fold and at the same time achieved an increase in its ascorbic acid content.

Loss of minerals from foods occurs as a result of leaching or extraction mainly during blanching and cooking operations, and the degree of loss depends upon the solubility of the mineral salts (8, 14). Depending chiefly upon the temperature and the length of storage time (10) changes continue to take place in canned foods after processing. However, under most processing conditions and according to Barrat (3), the mineral as well as the protein content of foods remains fairly stable. Heating of proteins, on the other hand, can cause loss of nutritive value because of the highly reactive nature of amino acids such as lysine and methionine (12) with reactive functional groups.

Elkins et al. (5) found that for green beans the hardness of the

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blanching water and the canning brine affect the retention of minerals in the solid portion and may cause a gain in minerals such as calcium, magnesium, and potassium.

Augustin et al. (2) found that nutrient variability in *Phaseolus vulgaris* beans freshly harvested while low in some minerals, eg, phosphorus and potassium was higher in other minerals studied such as manganese, iron, magnesium, calcium, and sodium. They also found that retention values after cooking in plain water generally exceeded 80%, except for sodium retention, which was in the range of 40%.

This research was undertaken to study the variability of the mineral content of various bean selections.

MATERIALS AND METHODS

Twenty-two selections of beans (kidney, white, and striped) were analyzed in this experiment. Beans were harvested at the Isabela Substation of the Agricultural Experimental Station located in the northwest of the Island. Beans were planted in winter. They were left to dry in the field before being harvested. Samples were brought to the Food Technology Laboratory and stored under controlled conditions (24° C and 60% RH) until used.

Canned beans were prepared by the commercial processing method, which consists in rehydration of the beans until doubling their dry weights, sorting, canning in 2% hot brine solution, exhausting in a vapor tunnel, and thermally processing in a retort at 15 lb/in^2 for about 20 min until 250° F (121° C) is reached.

For the nutrient analyses, the dry beans were ground to 40 mesh (0.420 mm). Canned samples were drained and the liquid portion discarded. The drained beans were dried in a force ventilated oven at 60° C and ground to 40 mesh.

Beans were then analyzed for Ca, Mg, Fe, Mn, P, Na, K, Cl, protein and ether extracts (fat). All analyses were performed on a dry weight basis. For mineral analyses, samples were dry ashed according to the A.O.A.C. (1).

Fat and Cl were determined according to the A.O.A.C. (1); Ca, Mg, Na, and K were determined by flame photometry, essentially as in the A.O.A.C. (1). P was determined by the method described by Fiske and Subbarrow (6), and N by the method described by Russell (17), both methods as modified by Technicon Co. (1960) and subsequently by Riera and Rivera Nuñez (15). Fe and Mn were determined spectrophotometrically by the orthophenanthroline and periodate methods, respectively, as described by Rubins (16), and modified for plant materials.

Results of these evaluations were submitted to analysis of variance

and the differences were compared with Duncan's multiple range test (11, 13).

RESULTS AND DISCUSSION

Table 1 summarizes the ranges in mineral, protein and fat composition of the bean selections studied, and table 2 shows the percentage gained or retained of the analyzed nutrients.

Calcium content in raw dry white beans was higher than in kidney and striped selections. However, in processed beans Ca content was significantly higher in kidney beans than in raw dry beans. This increase can be attributed to minor amounts of Ca in the water used for processing (8). The increase in Ca content was 25.28%. The highest increase in Ca content (33%) was in the white selection. The highest content of Ca was observed in Calima selection, but no significant differences were observed among Calima and Oro Rico, Bonita #4, Bonita #7, Abrams Africa, and Galana selections.

Magnesium content was lower in kidney beans, and there was no significant difference between raw dry and processed beans. The Mg content of white and striped beans was significantly higher in raw dry than in processed beans. The average Mg retention was 89%, which is considerably high. The Mg content after canning varied from 105.9% in Calima selection to 73% in Galana.

No significant differences were found between raw dry and processed beans or among selections with respect to Fe content. However, Fe content was higher in the raw dry beans than in processed beans. The Fe content in some bean selections increased. This increase can be attributed to minor amounts of Fe in the processing water and to absorption from the brine and from the can. Generally, the average Fe retention was 95%.

There were no significant differences in Mn between raw and processed beans or among the different varieties. The average difference in Mn between raw and processed beans was only 4.0 mg/100 g. The average retention of Mn was 89.8%.

Phosphorus was significantly higher in raw than in processed beans for all varieties. The average P retention was 67.4%. The highest P content was found in Cuarentena selection, but this content was not significantly higher when compared with Bonita #4, Bonita #7, Bonita #8, Colombia 91P, Galana, White 117, and Pompadour Dominicana.

A highly significant difference was observed between the Na content of raw dry and processed beans. This substantial increase in Na was expected since 2% table salt was added to the brine solution. The average Na percent increase was 97.6. Differences among selections were not significant.

TABLE 1.—*Selected nutrient content of dry and processed beans* (Phaseolus vulgaris) *per 100 g*

Variety	Selection	Raw (dry)										Processed									
		Ca	Mg	Fe	Mn	P	Na	Cl	K	Protein	Fat	Ca	Mg	Fe	Mn	P	Na	Cl	K	Protein	Fat
		mg	*mg*	*mg*	*mg*	*mg*	*mg*	*mg*	*g*	*g*	*g*	*mg*	*mg*	*mg*	*mg*	*mg*	*mg*	*g*	*g*	*g*	*g*
Kidney	Violeta	110	160	4.3	2.5	530	20	20	1.94	20.44	0.90	140	150	2.6	2.4	340	910	1.35	1.04	21.04	1.81
	Lajas	80	150	3.2	1.9	590	20	20	1.93	21.36	0.92	90	120	5.1	N.D.	370	940	1.38	0.67	22.12	1.56
	1973 (28)	90	140	3.3	1.9	560	20	20	1.96	23.41	0.94	110	140	2.5	1.4	370	930	1.32	1.06	23.73	1.84
	27R	100	170	4.9	1.7	555	30	20	1.96	23.30	0.93	110	140	3.2	0.4	360	930	1.36	1.06	22.01	0.72
White	Bonita #4	140	210	6.5	2.1	620	40	30	2.12	26.00	0.86	220	180	4.9	1.1	430	1000	1.43	1.25	25.79	0.88
	Bonita #7	140	220	6.4	1.7	630	20	20	2.06	25.35	0.71	210	170	5.9	2.8	420	920	1.41	1.09	26.11	0.74
	Bonita #8	120	200	8.5	1.9	620	20	20	2.22	24.00	1.00	180	180	4.7	2.4	430	970	1.41	1.15	25.73	0.63
	Abrams Africa	150	180	6.8	2.1	560	20	20	2.00	23.95	0.93	220	170	9.9	1.5	380	960	1.41	1.12	24.54	0.69
	Cuarentena	120	180	3.2	1.4	650	20	10	1.97	25.78	1.04	180	170	8.4	1.4	430	950	1.36	1.09	25.16	0.75
	White 142	150	200	3.6	2.1	570	20	20	2.07	23.75	1.26	220	170	4.3	1.2	380	960	1.42	1.18	25.46	1.11
	White 117	140	200	6.6	1.4	590	20	20	2.08	25.89	0.78	210	170	6.6	3.5	400	1000	1.45	1.16	25.78	0.50
Pinto	Dominicana #5	100	160	4.1	1.4	570	20	20	1.88	21.84	0.99	130	160	4.8	1.4	370	950	1.36	1.03	22.38	1.66
	Naranjito	80	150	3.2	0.7	540	30	20	1.88	20.50	1.09	110	150	2.5	1.4	350	910	1.30	1.03	21.04	1.44
	Pompadour Dominicana	110	160	3.8	1.9	540	20	20	1.88	21.36	0.95	130	160	5.2	0.7	430	950	1.36	1.25	22.74	1.00
	Galana	170	230	10.9	4.1	560	20	40	1.71	24.75	0.95	210	170	3.6	3.2	940	950	1.39	1.16	24.49	1.16
	Borinquen	100	170	5.0	2.8	560	20	20	1.93	23.62	0.96	100	140	6.8	1.9	380	970	1.47	1.11	24.06	1.13
	Pompadour	90	170	6.8	1.1	530	20	20	1.85	24.16	0.98	130	160	3.2	2.1	390	970	1.46	1.09	23.95	1.39
	Colombia 91P	120	180	5.4	5.0	630	20	40	2.02	25.30	1.13	180	160	1.7	1.1	380	950	1.43	1.22	21.36	1.34
	Calima	170	170	7.0	2.5	560	30	30	2.02	21.58	1.64	220	180	5.3	1.9	390	1060	1.48	1.17	20.28	1.47
	Rosita Lajas	70	190	3.2	1.0	530	30	20	2.06	23.30	1.11	110	160	4.8	2.1	330	1000	1.43	1.11	23.19	1.69
	Oro Rico	130	200	5.2	2.5	550	20	40	1.97	20.28	1.39	180	160	1.9	2.1	350	930	1.37	1.03	21.58	1.97
	Guayamesa	80	160	5.8	1.9	530	20	30	1.86	22.65	1.00	110	140	1.7	0.8	350	910	1.34	1.02	22.87	1.68

TABLE 2.—*Percent increase or retained of selected nutrients during canning of various bean* (Phaseolus vulgaris) *selections*

Variety	Selection	Ca	Mg	Fe	Mn	P	Na	Cl	K	Protein	Fat
Kidney	Violeta	21.4*[1]	93.8	60.5	96.0	64.2	97.8*	98.5*	53.6	2.9*	50.3*
	Lajas	11.1*	80.0	37.4*	N.D.[2]	62.7	97.8*	98.6*	34.7	3.4*	41.0*
	1973 (28)	18.2*	100.0	75.8	73.7	66.1	97.9*	98.5*	54.1	1.4*	48.9*
	27 R	9.1*	82.4	65.3	23.5	65.5	96.8*	98.5*	54.1	94.5	77.4
White	Bonita #4	36.4*	85.7	75.4	52.4	69.4	96.0*	97.9*	59.0	6.5*	2.3*
	Bonita #7	33.3*	77.3	92.2	16.5	66.7	97.8*	98.6*	53.9	2.9*	4.6*
	Bonita #8	33.3*	90.0	55.3	20.8*	69.4	97.9*	98.6*	51.8	6.7*	63.0
	Abrams Africa	31.8*	94.4	34.4*	71.4	67.9	97.9*	98.6*	50.9	2.4*	74.2
	Cuarentena	33.3*	94.4	61.9*	100.0	66.2	97.9*	99.3*	55.3	97.6	53.6
	White 142	31.8*	85.0	16.3*	57.1	66.7	97.9*	98.6*	57.0	6.7*	88.1
	White 117	33.3*	85.0	100.0	60.0*	67.8	98.0*	98.6*	55.8	99.6	64.1
Striped	Dominicana #5	23.1*	100.0	14.6*	100.0	64.9	97.9*	98.5*	54.8	2.4*	40.4*
	Naranjito	27.3*	100.0	78.1	50.0*	64.8	96.7*	98.5*	54.8	2.6*	24.3*
	Pompadour Dominicana	15.4*	100.0	26.9*	36.8	79.6	97.9*	98.5*	66.5	2.6*	5.0*
	Galana	19.1*	73.9	33.0	78.0	78.6	97.9*	97.1*	67.8	98.9	18.1*
	Borinquen	0	82.4	26.5	67.9	67.9	97.9*	98.6*	57.5	1.8*	15.1*
	Pompadour	30.8*	94.1	47.1	47.6*	73.6	97.9*	98.6*	58.9	99.1	29.5*
	Colombia 91P	33.3*	88.9	31.5	22.0	60.3	97.9*	97.2*	60.4	84.4	15.7*
	Calima	22.7*	5.6*	75.7	76.0	69.6	97.2*	98.7*	57.9	94.0	89.6
	Rosita Lajas	36.4*	84.2	33.3*	52.4*	62.3	97.0*	98.6*	53.9	99.5	34.3*
	Oro Rico	27.8*	80.0	36.5	84.0	63.6	97.9*	97.1*	52.3	6.3*	29.5*
	Guayamesa	27.3*	87.5	29.3	42.1	66.0	97.8*	97.8*	54.8	1.0*	40.5*

[1] Percent increase.
[2] Not detectable.

As in Na, and for the same reasons, the difference in Cl content between processed and raw dry beans was highly significant. The average Cl increase was 98.3%. No significant differences in Cl content were found among selections or among varieties.

There was a highly significant difference in K content between raw dry and processed beans in the three classes. However, no significant differences were found among selections. The average K retention was 55.4%, higher in the pinto selections.

No significant differences in protein content were found among bean selections or between raw dry and processed beans. However, the protein content of the white beans was highest. The average retention percentage was very high (96%). Thirteen selections showed a little increase in the protein content. The average percent increase was 3.5. The increase detected may be due to analytical error.

Except in the striped class, no significant differences were found in fat content between raw and processed beans. No significant differences were observed among bean selections. However, of the 22 bean selections studied, 15 of them showed an increase in fat content. The average fat increase was 26.6%. The tendency in white selections was to decrease in fat content. Aside from analytical errors, no explanation is found to account for this behavior.

Summing up, it can be said that Ca, Na, and Cl content of the bean selections studied were higher in processed beans than in dry beans while the amounts of Mg, P, and K were lower. No explanation may be advanced regarding the changes in fat content. It can also be said that the Fe, Mn and protein content remained constant.

White beans were the highest in most of the nutrients examined; striped beans were second highest.

With few exceptions, the data obtained in this study agree with those reported in the literature (2, 4, 8).

RESUMEN

Se evaluaron 22 selecciones de habichuelas de las clases marcadiablo (coloradas), blanca y pintas (galanas). Se estudió el efecto de la conservación comercial en latas sobre varios nutrimentos de la habichuela. Se analizaron muestras antes y después de elaborarlas.

Los contenidos de Ca, Na y Cl en las habichuelas aumentaron significativamente con el procedimiento. El aumento en Ca puede atribuirse a que el agua utilizada lo contiene. El contenido de Na y Cl aumentó porque las habichuelas se envasaron en agua de sal al 2%. El contenido de Fe aumentó en algunas muestras. El aumento en hierro puede atribuirse a su presencia en el agua o a la absorción de Fe del envase.

Los porcentajes de retención de Mg, Fe, Mn, P y K fueron de 89, 95, 89.8, 67.4 y 55.4, respectivamente.

Con muy pocas excepciones, los resultados obtenidos en este estudio concuerdan con otros efectuados por otros investigadores.

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